(30) Priority Data:

WORLD INTELLECTUAL PROPERTY ORGANIZATION International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶:

H02J 7/10

A1

(11) International Publication Number: WO 99/23738

(43) International Publication Date: 14 May 1999 (14.05.99)

(21) International Application Number: PCT/US98/22671

(22) International Filing Date: 26 October 1998 (26.10.98)

08/962,754 3 November 1997 (03.11.97) US

(71) Applicant: MIDTRONICS, INC. [US/US]; 8230 South Madison Street, Burr Ridge, IL 60521 (US).

(72) Inventors: BERTNESS, Kevin, I.; 1317 McChurg Drive, Batavia, IL 60510 (US). McSHANE, Stephen, J.; 3521 Madison, Oak Brook, IL 60521 (US).

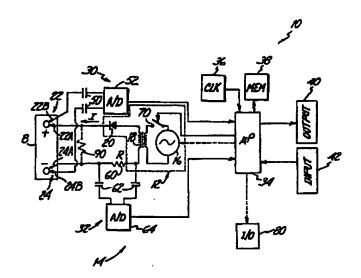
(74) Agents: CHAMPLIN, Judson, K. et al.; Westman, Champlin & Kelly, P. A., International Centre, Suite 1600, 900 Second Avenue South, Minneapolis, MN 55402-3319 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HU, ID, IL, IS, IP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: METHOD AND APPARATUS FOR CHARGING A BATTERY



(57) Abstract

An apparatus (10) for charging a battery (8) includes a first electrical connector (22) adapted to connect to a positive terminal of the battery (8) and a second electrical connector (24) adapted to connect to a negative terminal of the battery (8). An electrical charging source (18) couples to the first and second electrical connectors (22, 24) to charge the battery (8). Voltage measurement circuitry (52) couples to the first and second electrical connectors (22, 24) and responsively provides a voltage output related to voltage across the battery (8). Current measurement circuitry (60, 64) also couples to the first and second electrical connectors (22, 24) and responsively provides a current output related to electrical current through the battery (8). State of charge measurement circuitry responsively provides a state of charge output as a function of the voltage output and the current output.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Alberia	ES	Spain	LS	Lesotho	62	Slovenia
AM	Ameria	77	Finland	LT	Lithusnia	8K	Slovakia
AT	Anstria	PR	Prance	LU	Luxembourg	· SN	Scaceal
AU	Anstralia	GA	Gabon	LV	Latvia	872	Swaziland
AZ	Azerbalian	GB	United Kingdom	MC	Monaco	70	Chad
BA	Bosnia sad Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghena	MG	Madagascar	TJ	Taikhtao
BR	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Tericy
BG	Bulgaria	HU	Hungary	MI.	Mali	TT	Trinidad and Tobago
Ŋ	Benia	IE	Ireland	MIN	Mongolia	UA	Ukraine
BR	Brazil	1L	teraci	MR	Mauritania	UG	Uganda
- BY	Belarus	IS	lceland	MW	Malawi	US	United States of America
CA	Canada	IT	Raly	MX	Mexico	UZ	Uzbekistan
CIF	Central African Republic	JP	Зарки	NB	Niger	VN	Vict Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Carneroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania.		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DB	Germany	Ц	Liechtenstein	SD.	Sadan		
DK	Denmark	LK	Sri Lanka	SR.	Sweden		
KE.	Estonia	LR	Liberia	SG	Singapore		

15

20

25

30

PCT/US98/22671

METHOD AND APPARATUS FOR CHARGING A BATTERY BACKGROUND OF THE INVENTION

The present invention relates to rechargeable storage batteries. More specifically, the present invention relates to battery chargers of the type used to charge such batteries.

Chemical batteries which create electricity from chemical reactions have been known for many years. Such batteries are becoming increasing important and have found uses throughout industry. These uses include automobiles, UPS systems, etc.

One advantage of chemical batteries, such as lead acid storage batteries, is that they can be charged and their chemical process reversed by forcing electricity through the battery. Charging systems are widely known in the art and are widely available in the consumer market.

One of the most common techniques recharging storage batteries is simply placing a voltage source across the battery having a voltage which is greater than the battery voltage. The voltage difference will cause a charging current to flow through the battery causing a reversal of the chemical reaction. The charging current decreases as the voltage difference between the charging voltage and the battery voltage decreases. Typically, the charging voltage is selected to be greater than the nominal battery voltage in order to cause a slight overcharge of the battery. battery is deemed to be "charged" when the battery will accept no additional current. Frequently, this is through a simple visual inspection of an amp meter on the battery charger by the user of the battery charger. The battery charger may then be switched off.

WO 99/23738 PCT/US98/22671

-2-

However, such a simple technique for recharging a battery, although inexpensive, does not provide optimum battery charging and provides very little information about the battery itself. The device does not permit optimal rapid charging of the battery and may lead to excessive overcharging of the battery that can permanently damage the battery and even lead to boiling of the battery electrochemicals causing an unsafe environment. On the other hand, undercharging of a battery results in a battery that is not capable of providing its full potential output. These problems are exacerbated in situations where the battery is rapidly charged using large charging currents.

10

15

20

25

30

U.S. Patent No. 4,956,597, issued September 11, 1990 to Heavey et al. and is assigned to American Monarch Corporation, and entitled "METHOD AND APPARATUS FOR CHARGING BATTERIES" describes one technique in which battery voltage is monitored in an attempt to determine when a battery is fully charged. Another example is shown in U.S. Patent No. 5,642,031, entitled BATTERY RECHARGING SYSTEM WITH STATE OF CHARGE DETECTION THAT INITIALLY DETECTS WHETHER A BATTERY TO BE CHARGED IS ALREADY AT OR NEAR FULL CHARGE TO PREVENT OVERCHARGING, issued June 24, 1997 to Brotto. The Brotto patent describes a technique in which the charging current is periodically pulsed and the voltage decay is monitored.

SUMMARY OF THE INVENTION

An apparatus for charging a battery includes a first electrical connection adapted to connect to a positive terminal of the battery and a second electrical connector adapted to connect to a negative terminal of the battery. An electrical charging source couples to the first and second electrical connectors to charge the battery. Voltage measurement circuitry couples to the

15

20

25

30

first and second electrical connectors and responsively provides a voltage output related to voltage across the battery. Current measurement circuitry also couples to first and second electrical connectors responsively provides a current output related to electrical current through the battery. State of charge measurement circuitry responsively provides a state of charge output as a function of the voltage output and the current output. One aspect of the invention includes a state of charge output which increases as impedance decreases (and decreases as admittance increases) as determined by the voltage and current Another aspect of the invention includes battery rating storage circuitry which stores a rating related to the battery in a fully charged condition and the state of charge output is a function of a measured state of charge and the battery rating. expressed, for example, as a percentage charge.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified block diagram of a battery charging system in accordance with the present invention.

Figure 2 is a graph of CCA versus time.

Figure 3 shows an output display in accordance with one embodiment of the present invention.

Figure 4 is a graph of CCA versus time for a battery with a bad cell.

Figure 5 is a graph of terminal voltage versus time for three batteries under a load test.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention provides an apparatus for charging a battery which is also capable of monitoring the condition of the battery. Such monitoring can be used to provide information to an

. 5

25

30

operator, or to provide feedback to control the charging. The invention uses the charging current and voltage themselves to advantageously determine battery condition. Thus, a battery charger in accordance with the present invention is capable of determining the status of the battery, making advanced decisions about charging the battery and selecting a particular charging profile used in such charging.

Figure 1 is a simplified block diagram of a battery charging system 10 in accordance with the 10 present invention coupled to storage battery 8. System 10 includes battery charger circuitry and test circuitry 14. Battery charge circuitry 12 generally includes AC source 16, transformer 18 and rectifier 20. System 10 couples to battery 8 through electrical connection 22 15 which couples to the positive terminal of battery 8 and electrical connection 24 which couples to the negative terminal of battery 8. In one preferred embodiment, a four point (or Kelvin) connection technique is used in which battery charge circuitry 12 couples to battery 8 20 through electrical connections 22A and 24B while battery testing circuitry 14 couples to battery 8 through electrical connections 22A and 24B.

Battery testing circuitry 14 includes voltage measurement circuitry 30 and current measurement circuitry 32 which provide outputs to microprocessor 34. Microprocessor 34 also couples to a system clock 36 and memory 38 which is used to store information and programming instructions. In the embodiment of the invention shown in Figure 1, microprocessor 34 also couples to user output circuitry 40 and user input circuitry 42.

Voltage measurement circuitry 34 includes capacitors 50 which couple analog to digital converter

52 to battery 8 through electrical connections 22B and 24B. Any type of coupling mechanism may be used for element 50 and capacitors are merely shown as one Further, the device may also preferred embodiment. couple to DC signals. Current measurement circuitry 32 includes a shunt resistor (R) 60 and coupling capacitors 62. Shunt resistor 60 is coupled in series with battery charging circuitry 12. Other current measurement techniques are within the scope of the invention including Hall-Effect sensors, magnetic or indicative coupling, etc. An analog to digital converter 64 is connected across shunt resistor 60 by capacitor 62 such that the voltage provided to analog to digital converter 64 is proportional to a current I flowing through battery 8 due to charging circuitry 12. digital converter 64 provides a digitized output representative of this current to microprocessor 34.

10

15

20

25

30

During operation, AC source 16 is coupled to battery 8 through transformer 18 and rectifier 20. Rectifier 20 provides half way rectification such that current I has a non-zero DC value. Of course, full wave rectification or other AC sources may also be used. Analog to digital converter 64 provides a digitized output to microprocessor 34 which is representative of current I flowing through battery 8. Similarly, analog to digital converter 52 provides a digitized output representative of the voltage across the positive and negative terminals of battery 8. Analog to digital converters 52 and 64 are capacitively coupled to battery 8 such that they measure the AC components of the charging signal.

Microprocessor 34 determines the conductance of battery 8 based upon the digitized current and voltage information provided by analog to digital

10

20

25

30

converters 64 and 52, respectively. Microprocessor 34 counts the conductance of battery 8 as follows:

Conductance-
$$G = \frac{I}{V}$$
,

Eq. 1.

where I is the charging current and V is the charging voltage across battery 8. Note that in one preferred embodiment the Kelvin connections allow more accurate voltage determination because these connections do not carry substantial current to cause a resultant drop in the voltage measured.

In accordance with the present invention, the battery conductance is used to monitor charging of battery 8. Specifically, it has been discovered that as a battery is charged the conductance of the battery This rise in conductance can be monitored in microprocessor 34 to determine when the battery has been 15 fully charged. For example, if the rate of the rise in conductance slowly decreases, such that the conductance reaches a substantially constant value, microprocessor 34 determines that battery 8 is fully charged and disconnect charging circuitry 12 using switch 70. Further, in one aspect of the present invention, microprocessor 34 responsively controls the rate of charge by adjusting AC source 16 to reduce the likelihood that battery 8 is damaged by significant overcharge.

Furthermore, microprocessor 34 can calculate cold cranking amps (CCA) of battery 8 using the formula:

CCA - K·G

where K is constant which may be selected for a specific battery and G is given in Equation 1. Figure 2 is a graph of CCA versus time in minutes for three different

10

15

batteries having three different nominal CCA ratings. This particular graph shows that after about 25 to 30 minutes, each battery has reached its nominal CCA rating.

One aspect of the invention includes storing information in microprocessor 34 or memory 38 which relates to battery 8. For example, this information could be the battery's nominal CCA rating as input through input 42 by an operator. Further, the make and model of the battery may be input by an operator through input 42 and information related to that specific battery type recovered from memory 38. In general, the rating of the battery may be input in the form of CCA, amp hours, RC, JIS number, stock number, battery construction or chemistry, etc. For example, if a nominal or reference conductance (GREPHERECE) is stored in memory, a relative conductance determination can be made by microprocessor 34 using the equation:

Relative Conductance (%) -
$$\frac{G_{\text{measured}}}{G_{\text{reference}}} \times 100$$
, Eq. 3

20 where Gmeasured is the battery conductance in accordance with Equation 1. Generally, this reference conductance is determined based upon type and characteristics of battery 8. This technique is described in U.S. Patent No. 5,140,269, entitled ELECTRONIC TESTER FOR ASSESSING BATTERY/CELL CAPACITY, 25 issued August 18, 1992 to This may be converted into a display for output on output 40 such that an operator may monitor the charging of battery 8. For example, Figure 3 shows one embodiment of output 40 in which a bar graph is 30 provided with indications for "empty" and "full." the embodiment shown in Figure 3, a half reading "full"

is shown. This may be implemented through an LED display, for example. Other examples of desirable outputs include outputs which appear as a gauge or other visual indication of the battery condition. Other types of outputs include outputs indicating the recovering of amp hours, state of charge, reserve capacity, time to full charge or run time remaining. This may be shown in percentages, numerically, graphically, etc.

10

15

20

25

30

One general aspect of the present invention includes a technique for providing feedback control of a battery charger where the feedback control is a function of charging voltage and charging current. one embodiment, bad cells or shorted cells are detected when the rate of change of the conductance is greater than a predetermined threshold. For example, Figure 4 is a graph of CCA versus time for a battery (nominal conductance of 500 CCA) being charged in accordance with the invention which developed a bad cell during testing. The graph of Figure 4 shows an abnormal change in conductance in comparison to the graphs of Figure 2. This can be used to control the charging rate, or to stop the charging rate and give a fault indication using output 40. Further, an initial load test may be applied to the battery using load resistance 90 to determine if there is a bad cell by observing a resultant decline in voltage versus time using voltage measurement circuitry 30. This is illustrated in the graph of Figure 5 which shows battery terminal voltage versus time for two good batteries and one battery with a bad cell. other diagnostics may be performed such as those described in U.S. Patent No. 5,574,355, entitled METHOD AND APPARATUS FOR DETECTION AND CONTROL OF THERMAL RUNAWAY IN A BATTERY UNDER CHARGE, issued November 12, 1996 to McShane et al.

WO 99/23738 PCT/US98/22671

The present invention advantageously uses the charging current and voltage to determine the condition of the battery. This allows for continuous testing during battery charging and the battery charger does not need to be taken off line. Further, the measurement is not adversely affected by electrical noise in the system.

5

10

15

20

25

30

Another aspect of the present invention includes an I/O port or link 80 which is adapted to be coupled to an external device, such as an external battery tester, printer, storage device, automotive analysis device, etc. This may be a physical look, or, in one embodiment, this I/O link is through an infrared (IR), radio frequency (RF), or ultrasonic connection such that a physical link between the two units is not necessary. For example, the results from a previously performed battery test can be supplied to system 10 by a separate battery tester, whereby the initial condition of battery 8 is used during charging. Similarly, an external or separate device can communicate information such as the model number or type of battery being charged.

The present invention advantageously uses a Kelvin connection in which the electrical connection to the battery includes two connections for charging and two connections for a separate voltage measurement.

Additionally, during charging, the rate of increase of the voltage may be selectively monitored to determine charging efficiency and other characteristics of the battery.

One type of output that can be provided on output 40 includes various types of auditing codes as those set forth in co-pending application Serial No. 08/681,730, entitled "METHOD AND APPARATUS FOR AUDITING

A BATTERY TEST", filed July 29, 1996 which is commonly assigned with the present application. Additional codes include the sequence code which can indicate the order in which tests were made on an individual battery tester or a time code which indicates the date and time at which a test was made.

In general, although the formulas techniques set forth herein discuss determination of conductance, the present invention may also be implied to impedance measurements, resistance measurements or 10 admittance measurements of the storage battery. Further, although a microprocessor and digital circuitry is disclosed herein, the present invention may also be implemented in analog circuitry. In general, various techniques for measuring battery conductance are show in 15 a number of patents including, for example, U.S. Patent No. 3,873,911, issued March 25, 1975, to Champlin, entitled ELECTRONIC BATTERY TESTING DEVICE; U.S. Patent No. 3,909,708, issued September 30, 1975, to Champlin, entitled ELECTRONIC BATTERY TESTING DEVICE; U.S. Patent 20 No. 4,816,768, issued March 28, 1989, to Champlin, entitled ELECTRONIC BATTERY TESTING DEVICE; U.S. Patent No. 4,825,170, issued April 25, 1989, to Champlin, entitled ELECTRONIC BATTERY TESTING DEVICE WITH AUTOMATIC VOLTAGE SCALING; U.S. Patent No. 4,881,038, 25 issued November 14, 1989, to Champlin, entitled ELECTRONIC BATTERY TESTING DEVICE WITH AUTOMATIC VOLTAGE SCALING TO DETERMINE DYNAMIC CONDUCTANCE; U.S. Patent No. 4,912,416, issued March 27, 1990, to Champlin, entitled ELECTRONIC BATTERY TESTING DEVICE WITH STATE-30 OF-CHARGE COMPENSATION; U.S. Patent No. 5,140,269, issued August 18, 1992, to Champlin, entitled ELECTRONIC TESTER FOR ASSESSING BATTERY/CELL CAPACITY; U.S. Patent 4,322,685, issued March 30, 1982, entitled AUTOMATIC

WO 99/23738 PCT/US98/22671

BATTERY ANALYZER INCLUDING APPARATUS FOR DETERMINING PRESENCE OF SINGLE BAD CELL; U.S. Patent No. 5,343,380, issued August 30, 1994, entitled "METHOD AND APPARATUS FOR SUPPRESSING TIME VARYING SIGNALS IN BATTERIES UNDERGOING CHARGING OR DISCHARGING"; U.S. Patent No. 5,572,136, issued November 5, 1996, entitled *ELECTRONIC BATTERY TESTER WITH AUTOMATIC COMPENSATION FOR LOW STATE-OF-CHARGE"; U.S. Patent No. 5,574,355, issued November 12, 1996, entitled METHOD AND APPARATUS FOR DETECTION AND CONTROL OF THERMAL RUNAWAY IN A BATTERY UNDER CHARGE"; U.S. Patent No. 5,585,728, issued December 17, 1996, entitled "ELECTRONIC BATTERY TESTER WITH AUTOMATIC COMPENSATION FOR LOW STATE-OF-CHARGE"; U.S. Patent No. 5,598,098, issued January 28, 1997, entitled "ELECTRONIC BATTERY TESTER WITH VERY HIGH NOISE IMMUNITY"; and U.S. Patent No. 5,592,093, issued January 7, 1997, entitled "ELECTRONIC BATTERY TESTING DEVICE LOOSE TERMINAL CONNECTION DETECTION VIA A COMPARISON CIRCUIT".

10

15

Although the present invention has been 20 described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. voltages and currents measured herein are set forth as 25 alternating signals and their measurements may be through RMS values, peak-to-peak measurements, etc. However, other techniques may be employed and DC signals may also be monitored. In a typical battery charger, the AC component of the charging signal is related to 30 the line frequency and thus, in the United States, is typically 60 Hz or 120 Hz. However, other frequencies may also be employed. Further, the charge signal may be a stepped DC signal and the voltage and current

-12-

measurement circuitry responsive to step DC signals. In general, the invention determines battery and/or charging conditions based upon a ratio of charging voltage and charging current.

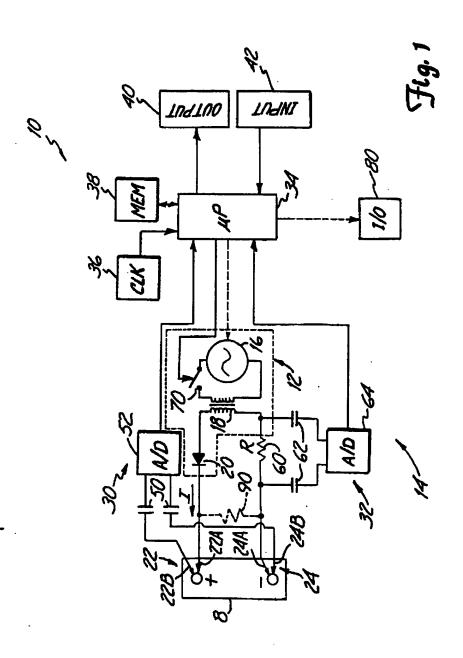
WHAT IS CLAIMED IS:

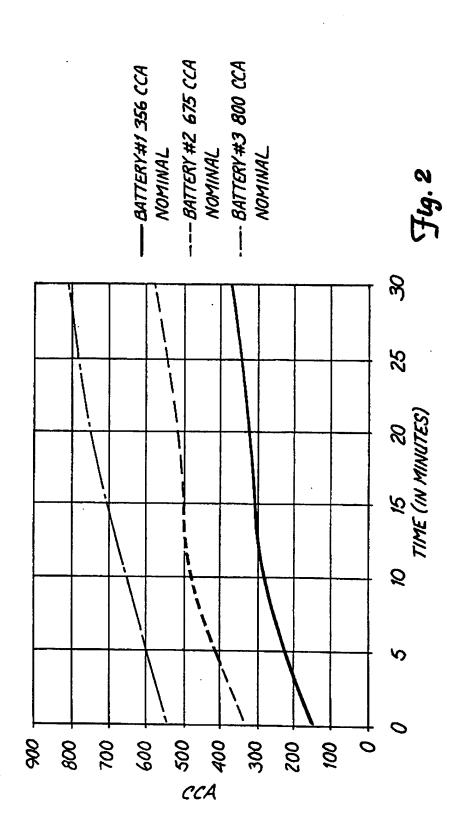
- 1. An apparatus for charging a battery, comprising:
 - a first electrical connector adapted to connect to a positive terminal of the battery;
 - a second electrical connector adapted to connect to a negative terminal of the battery;
 - an electrical charging source providing a charge signal to the first and second connectors to charge the battery;
 - voltage measurement circuitry coupled to the first and second electrical connectors responsively providing a sensed voltage output related to a charging voltage;
 - current measurement circuitry coupled to the first and second electrical connectors responsively providing a sensed current output related to a charging current; and
 - state of charge measurement circuitry responsively providing state of charge output as a function of the sensed voltage output and the sensed current output.
- 2. The apparatus of claim 1 wherein the state of charge output increases as battery impedance decreases and increases as battery admittance increases based upon the sensed voltage and current outputs.
- 3. The apparatus of claim 1 including battery rating storage circuitry storing a rating related to the battery in a fully charged condition and wherein the

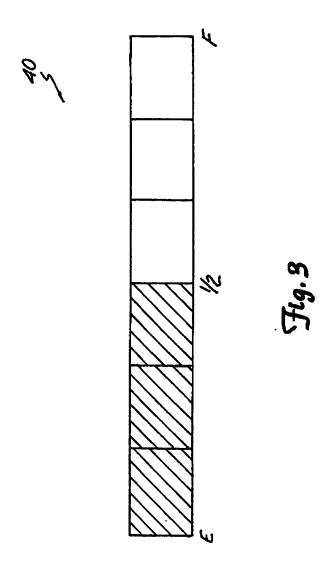
state of charge output is a function of measured state of charge and the stored battery rating.

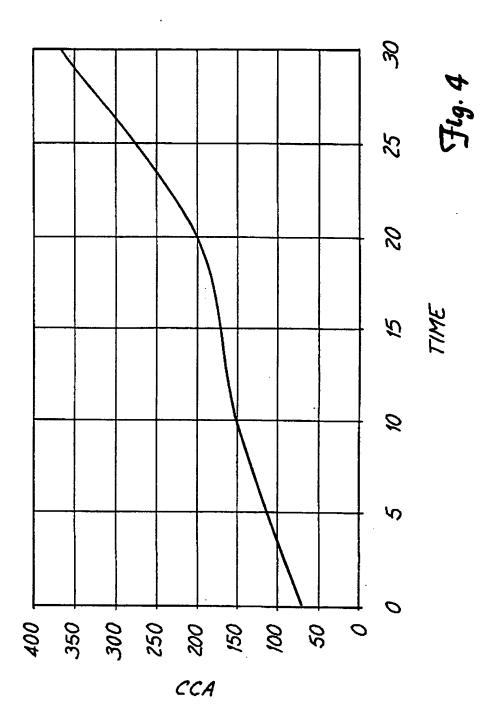
- 4. The apparatus of claim 3 wherein the state of charge output is a percentage.
- 5. The apparatus of claim 1 wherein the electrical charging source provides a rectified signal to charge the battery.
- 6. The apparatus of claim 1 wherein the current measurement circuitry includes a resistor placed in series with the electrical charging source to generate a voltage drop thereacross.
- 7. The apparatus of claim 1 wherein the current measurement circuitry includes a Hall-Effect sensor which provides the sensed current output as a voltage.
- 8. The apparatus of claim 1 wherein the current measurement circuitry includes a magnetic pickup dence which provides the sensed current output as a voltage.
- 9. The apparatus of claim 1 wherein the state of charge output is a function of the sensed current output divided by the sensed voltage output.
- 10. The apparatus of claim 1 wherein the state of charge measurement circuitry comprises a microprocessor.
- 11. The apparatus of claim 1 wherein the charge signal from the electrical charging source is responsive to the state of charge output from the state of charge measurement circuitry.
- 12. The apparatus of claim 11 wherein the charge signal is reduced as the state of charge of the battery increases.
- 13. The apparatus of claim 3 including input circuitry for receiving an input related to battery rating for storage in the battery rating storage circuitry.

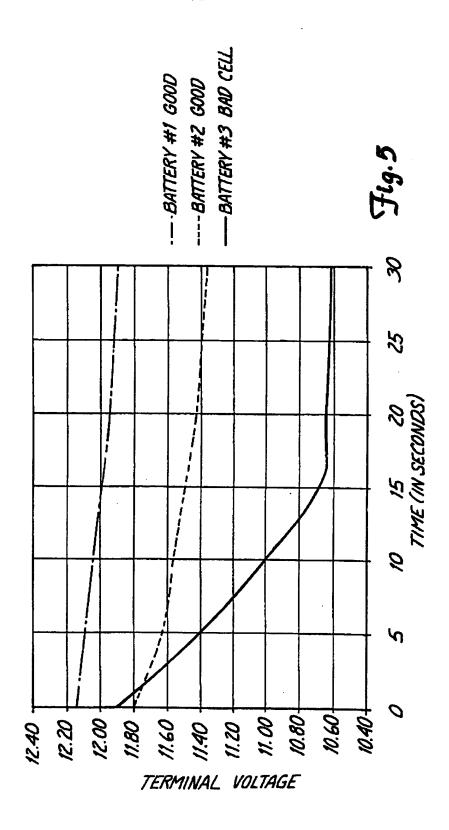
- 14. The apparatus of claim 13 wherein the input is a user input.
- 15. The apparatus of claim 14 wherein the user input is selected from the group consisting of battery make, battery model, battery type, battery part number and battery rating.
- 16. The apparatus of claim 1 including a load resistance for performing a load test on the battery.
- 17. The apparatus of claim 1 wherein the charge signal includes an AC component.
- 18. The apparatus of claim 17 wherein the voltage and current measurement circuits are responsive to AC signals.
- 19. The apparatus of claim 18 wherein the voltage and current measurement circuits measure RMS.
- 20. The apparatus of claim 18 wherein the voltage and current measurement circuits measure peak-to-peak.
- 21. The apparatus of claim 1 wherein the charge signal includes a stepped DC component.
- 22. The apparatus of claim 21 wherein the voltage and current circuits are responsive to step changes in DC levels.
- 23. The apparatus of claim 1 wherein the state of charge measurement circuitry provides an output indicative of a bad cell in the battery in response to the sensed voltage and current outputs.
- 24. The apparatus of claim 1 including a parameter input and the state of charge output is further a function of a parameter input.
- 25. The apparatus of claim 24 wherein the input is received over a non-physical link.
- 26. The apparatus of claim 25 wherein the non-physical link is selected from the group consisting of IR, RF, and ultrasonic.











INTERNATIONAL SEARCH REPORT

1 tettonal Application No PCT/US 98/22671

According to informational Pleant Classification (IPC) or to both national classification and IPC B FIELDS SEARCHED Minimum documentation examined (classification system followed by classification symbols) IPC 6 H02J G01R Documentation searched defroit minimum documentation to the autent that such documents are inclused in the battle searched Documentation searched defroit the imminimum documentation to the autent that such documents are inclused in the battle searched Documentation searched defroit the imminimum documentation to the autent that such documents are inclused in the battle searched Documentation searched defroit the imminimum documentation to the autent that such documents are inclused in the battle searched Documentation searched defroit the imminimum documentation of the search forms used) The search searched defroit the imminimum documentation of the search forms used that bases and, where predicted, essenth forms used) The search searched defroit the imminimum documents are inclused in the searched in the searched in the searched in the searched defroit the searched in the						
B. PELDS SEARCHED Mornium documentation isolateriad (bisselfication system followed by classification symbols) Documentation searched other than minimum documentation to the actions that each documents are included in the Balds searched Eductionic data base consulted during the International search (name of data base and, where precidual, search forms used) Eductionic data base consulted during the International search (name of data base and, where precidual, search forms used) C. DOCUMENTS CONSIDERED TO BE RELEVANT Category* Chatton of document, with indication, where appropriate, of the relevent passages Palevent to claim No. 27 December 1983 See the whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 see the whole document Y US 3 984 762 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 see the whole document Y GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 see the whole document Y GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 See the whole document Y Garden or dated documents: ** document dering the person and and on profity charity or which is not constituted to be operational reference ** and occument of the profity date and not in corlet with the speciation but only of the profity date and not in corlet with the speciation for which is not constituted to the profity date and on in corlet with the speciation for which is the constituted on the profity date and not in corlet with the speciation for which is not constituted to the operational reference **Cocument dering the secretary of the profity date and not in corlet with the speciation for the secretary of the profity date and not in corlet with the speciation for the secretary of particular reservance, the claimed inventors are shown to the profity date and not in corlet with the speciation for the comments of the profity date and not in corlet with the speciation for the content of the profity date and not in corlet with the specia	A. CLASSI IPC 6	FICATION OF SUBJECT MATTER H02J7/10		. ——		
B. PELDS SEARCHED Mornium documentation isolateriad (bisselfication system followed by classification symbols) Documentation searched other than minimum documentation to the actions that each documents are included in the Balds searched Eductionic data base consulted during the International search (name of data base and, where precidual, search forms used) Eductionic data base consulted during the International search (name of data base and, where precidual, search forms used) C. DOCUMENTS CONSIDERED TO BE RELEVANT Category* Chatton of document, with indication, where appropriate, of the relevent passages Palevent to claim No. 27 December 1983 See the whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 see the whole document Y US 3 984 762 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 see the whole document Y GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 see the whole document Y GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 See the whole document Y Garden or dated documents: ** document dering the person and and on profity charity or which is not constituted to be operational reference ** and occument of the profity date and not in corlet with the speciation but only of the profity date and not in corlet with the speciation for which is not constituted to the profity date and on in corlet with the speciation for which is the constituted on the profity date and not in corlet with the speciation for which is not constituted to the operational reference **Cocument dering the secretary of the profity date and not in corlet with the speciation for the secretary of the profity date and not in corlet with the speciation for the secretary of particular reservance, the claimed inventors are shown to the profity date and not in corlet with the speciation for the comments of the profity date and not in corlet with the speciation for the content of the profity date and not in corlet with the specia			•			
Interest described in the Balds searched (bleastfloation system followed by classification symbols) Documentation searched other than maintain documentation to the authors that such documents are included in the Balds searched Electronic data base consulted during the International search (name of data base and, where practical, search forms used) C. DOCUMENTS CONSIDERED TO BE RELEVANT Category* Clastion of document, with indication, whome appropriate, of the relevent passages Relevant to clastin No. 27 December 1983 See the Whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 See the Whole document Y US 3 984 762 A (DONGTALLO JR EDWARD J) 5 October 1996 See the Whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 3 June 1982 See the Whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 1,6,9, 3 June 1982 See the Whole document The author documents are listed in the continuation of box C. **Special categories of cated documents:* **Concurrent forms that published on the or published on the or published on the or published on the published on the or published on the			idion and IPC			
Documentation searched other than minimum documentation to the extent that such documents are included in the Sedie searched Documentation searched other than minimum documentation to the extent that such documents are included in the Sedie searched Documentation searched other than minimum documentation to the extent that such document is an included during the international search (partner of data base and, where product, search forms used) C. DOCUMENTS CONSIDERED TO BE RELEVANT. Category* Cate						
Electronic data base consulted during the International search (name of data base and, where predical, search forms used) C. DOCUMENTS CONSIDERED TO BE RELEVANT. Category ** Chatton of document, with indication, where appropriate, of the relevent passages			on symbols)			
C. DOCUMENTS CONSIDERED TO BE RELEVANT. Category* Clation of document, with indication, where appropriate, of the relevant pessages Palevant to claim No. 3, 10, 13-15, 24 3 See the Whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 See the Whole document Y US 3 984 762 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the Whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 See the Whole document Y US 3 984 764 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the Whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 See the Whole document Y US 3 984 765 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the Whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 1,6,9, 11,12 3,10, 13-18, 23,24 -/- X Palevant barrilly mombare are listed in the continuation of box C. X Palevant barrilly mombare are listed in annex. ** Special categories of cited documents: ** document documents barrilly the profession of the an which is not control to be of paticular relevance of the state of the control to control the controlled of the state o	Documental	tion searched other than minimum documentation to the extent that e	uch documents are included in the fields se	arched		
C. DOCUMENTS CONSIDERED TO BE RELEVANT. Category* Clation of document, with indication, where appropriate, of the relevant pessages Palevant to claim No. 3, 10, 13-15, 24 3 See the Whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 See the Whole document Y US 3 984 762 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the Whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 See the Whole document Y US 3 984 764 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the Whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 3 June 1982 See the Whole document Y US 3 984 765 A (DOWGIALLO JR EDWARD J) 5 October 1976 See the Whole document X GB 2 088 159 A (HARNER & SIMMONS LTD) 1,6,9, 11,12 3,10, 13-18, 23,24 -/- X Palevant barrilly mombare are listed in the continuation of box C. X Palevant barrilly mombare are listed in annex. ** Special categories of cited documents: ** document documents barrilly the profession of the an which is not control to be of paticular relevance of the state of the control to control the controlled of the state o	Electronic d					
Cstagory* Clastion of document, with indication, where appropriate, of the relevant passages Relevant to claim No. Y US 4 423 379 A (JACOBS WILLIAM R ET AL) 3,10, 27 December 1983 3 see the whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 3 see the whole document Y US 3 984 762 A (DOMGIALLO JR EDWARD J) 5 October 1976 5 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 3 June 1982 5 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 1,6,9, 3 June 1982 5 see the whole document Y US 3 944 762 A (DOMGIALLO JR EDWARD J) 5 October 1976 5 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 1,6,9, 3 June 1982 5 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 1,3-18, 23,24 -/- X Patent termity members are letted in the continuation of box C. X Patent fermity members are letted in arriver. **Comment of both particular relevance **Comment of both particular relevance **Comment of particular relevance in consistent of the content in the service of the content in the content in the service of the content in t			as and where homes are not the record			
Cstagory* Clastion of document, with indication, where appropriate, of the relevant passages Relevant to claim No. Y US 4 423 379 A (JACOBS MILLIAM R ET AL) 3,10, 27 December 1983 3 see the whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 3 see the whole document Y US 3 984 762 A (DOMGIALLO JR EDWARD J) 5 October 1976 5 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 3 June 1982 5 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 1,6,9, 3 June 1982 5 see the whole document X Patent family members are listed in the continuation of box C. X Patent family members are listed in the continuation of box C. X Patent family members are listed in arriver. **Cocument of collection of both particular relevance **Cocument of particular relevance **Cocument referring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to an oral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to a noral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to a noral disclosure, use, exhibition or other special meson (se specifical of another cofter members **Cocument inferring to a noral disclosure, use, exhibition or other special meson (se specifical of another cofte	C. DOCUM	ENTS CONSIDERED TO BE RELEVANT				
Y US 4 423 379 A (JACOBS WILLIAM R ET AL) 27 December 1983 see the whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 see the whole document Y US 3 984 752 A (DOMGIALLO JR EDWARD J) 5 October 1976 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 1, 6, 9, 3 June 1982 see the whole document Y US 68 2 088 159 A (HARMER & SIMMONS LTD) 1, 1, 2 3, 10, 13-18, 23, 24 -/- X Patent territy members are listed in the continuation of box C. Y Patent territy members are listed in annex. Y Comment of thing the general state of the art which is not contained to be of particular relevance. Y Comment of thing the general state of the art which is not contained to be of particular relevance. Y Comment of thing the general state of the art which is not contained to be of particular relevance. Y Comment of thing the general state of the art which is not contained to be of particular relevance. Y Comment of thing the general state of the art which is not contained to be often as the international fling date of the state of the state of the state of the general state of the particular relevance of the protein state of the protein				Delegant to cisto tis		
27 December 1983 see the whole document A US 5 457 377 A (JONSSON LENNART ET AL) 10 October 1995 see the whole document Y US 3 984 762 A (DOWGIALLO JR EDWARD J) 5 October 1976 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 3 June 1982 see the whole document Y US 3 984 762 A (DOWGIALLO JR EDWARD J) 11,12 Y 3,10, 13-18, 23,24 -/- X Pasers samily mornbars are letted in the continuation of box C. X Pasers samily mornbars are letted in an extensional filing data or priority data distra the international filing data or priority data and not in conflict with the epplication but obtain in a direct or established or soften special reason (as epposited on or start the international filing data or obcument such distribution and the publication data of another collision or other special reason (as expected on or start or the international filing data or obcument such distribution or other special reason (as expected on or start or the data document to internate a contribute on the document to be seen the document and the invention control to considered to invention control to considered with one or or more stept when the document a bitain at an an extension of the step of the s	Catagory	Caston of co-centers, with automore, where appropriate, or the re-	event basesiges	Preservent to Casari No.		
10 October 1995 see the whole document Y US 3 984 762 A (DOMGIALLO JR EDMARD J) 5 October 1976 see the whole document X GB 2 088 159 A (HARMER & SIMMONS LTD) 3 June 1982 11,12 see the whole document Y 3,10, 13-18, 23,24 -/- X Further documents are listed in the continuation of box C. Y Special categories of cited documents: 'A' document dofining the general state of the art which is not constained to be of particular relevance constained to be of particular relevance The artier document which may throw doubte on priority claime) or which is cited to ordinate the problem of	Y	27 December 1983	ET AL)			
Social categories of cited documents: **The state of comments are listed in the continuation of box C. **Special categories of cited documents: **A document dofining the general state of the art which is not constituted to involve an invention and the principle or theory underlying the continuation or other special meson (see specifical) **Comment dofining the general state of the art which is not consistent to be of particular relevance **Comment dofining the general state of the art which is not consistent to be of particular relevance **Comment of particular relevance to the claimed invention of the state of the particular relevance; the claimed invention continuation or other special reason (see specified) **Comment of particular relevance; the claimed invention continuation or other special reason (see specified) **Comment of particular relevance; the claimed invention continuation or other special reason (see specified) **Comment of particular relevance; the claimed invention continuation or other special reason (see specified) **Comment of particular relevance; the claimed invention control be considered to involve an inventive stop when the document is blaimed in the principal state claimed **Comment of particular relevance; the claimed invention control be considered to involve an inventive stop when the document becomes the considered to involve an inventive stop when the document of comment of particular relevance; the claimed invention control becomes the considered to involve an inventive stop when the document of comment of particular relevance; the claimed invention control becomes the considered to involve an inventive stop when the document of comment of particular relevance; the claimed invention control becomes the considered to involve an inventive stop when the document of comment of particular relevance; the claimed invention control becomes the considered to involve an invention stop when the document of comment of particular relevance; the claimed invention control to consider	A	10 October 1995	ET AL)	1-26		
3 June 1982 See the whole document 3, 10, 13-18, 23, 24 —/— X Pasert tently members are listed in the continuation of box C. X Pasert tently members are listed in arriex. *Special categories of cited documents: A document dofining the general state of the art which is not considered to be of particular relevance E earlier document but published on or star the intermetional filling date *C excellent which respect which may throw doubte on priority claim(s) or which is olded to establish the publication date of another obtain or orbiter special research as established or or other special research as a substitution or other special research as a substitution or other special research as a substitution or other research published prior to the intermetional filling date but inter stan the priority date claimed Date of the actual completion of the intermetional search 22 January 1999 Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentiaen 2 Nat. 2280 HV Rijewitk. A June 1982 11, 12 3, 10, 13-18, 23, 24 The letter document published after the Intermetional filling date or priority date and not in conflict with the application but does not record the expedication but does not record the star the special research report of countered to principle or theory underlying the invention cannot be considered novel or current be considered to involve an inventive step when the document is believed the stan the priority date claimed Date of mailing address of the ISA European Patent Office, P.B. 5818 Patentiaen 2 Nat. 2280 HV Rijewitk. A June 1982 11, 12-18 3, 10, 13-18, 223, 24 The letter document published after the Intermetional filling date or priority date and not in conflict with the application to the orbit date for the stan and not in conflict with the application to the stan and not in conflict with the application to the orbit date of particular relevance; the claimed invention cannot be considered to involve an invention and not or considered to involve an invention o	Υ	5 October 1976	ARD J)	16,18		
Turther documents are listed in the continuation of box C. X Patent tamily members are listed in annex.	x	3 June 1982	LTD)			
Further documents are listed in the continuation of box C. The process of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance. "E" earlier document but published on or efter the international filing date or priority date and not in conflict with the application but obed to understand the principle or theory underlying the invention. "E" document but published on or efter the international filing date or which is cited to celebrate the publication date of another other neare. "O" document referring to an oral disclosure, use, admittion or other meane. "P" document published prior to the international filing date but later than the priority date claimed. Date of the actual completion of the international search Date of the actual completion of the international search European Patent Office, P.B. 6818 Patentiase 2 Na 2280 HV Piliparity. Tot (483-70) 200-000 To St. 51 55 4 and of 100 control to considered in annex. "T" later document published after the international filing date or priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application of priority date and not in conflict with the application of priority date and not in conflict with the application of priority date and not in conflict with the application of priority date and not in conflict with the	Y	See the whole document		13-18,		
Further documents are listed in the continuation of box C. The process of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance. "E" earlier document but published on or efter the international filing date or priority date and not in conflict with the application but obed to understand the principle or theory underlying the invention. "E" document but published on or efter the international filing date or which is cited to celebrate the publication date of another other neare. "O" document referring to an oral disclosure, use, admittion or other meane. "P" document published prior to the international filing date but later than the priority date claimed. Date of the actual completion of the international search Date of the actual completion of the international search European Patent Office, P.B. 6818 Patentiase 2 Na 2280 HV Piliparity. Tot (483-70) 200-000 To St. 51 55 4 and of 100 control to considered in annex. "T" later document published after the international filing date or priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application but one priority date and not in conflict with the application of priority date and not in conflict with the application of priority date and not in conflict with the application of priority date and not in conflict with the application of priority date and not in conflict with the			-/ 			
"A" document dofining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filling date "L" document which may throw doubte on priority claimte) or which is cited to establish the publication date of another chation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filling date but left that the priority date claimed Date of the actual completion of the international search Date of the actual completion of the international search European Petant Office, P.B. 5618 Patentiaen 2 Name and mailing address of the ISA European Petant Office, P.B. 5618 Patentiaen 2 Na 2280 HV Rijawijs. Tel (483-77) 340-0246 Tr. D. 6414 annual.	X Furt			in annex.		
"A" document defining the general state of the art which is not considered to be of particular relevance. "E" artifer document but published on or after the international filling date. "L" document which may throw doubte on priority claim(s) or which is olded to establish the publication date of another chatton or other special reason (se specified). "O" document referring to an oral disclosure, use, exhibition or other means. "P" document published prior to the international filling date but later than the priority date claimed. Date of the actual completion of the international search. Date of the actual completion of the international search. 22 January 1999 Name and mailing address of the ISA. European Patant Office, P.B. 5618 Patentiaen 2. Na 2280 HV Rijawijs. Pat 4643-710 3463-2046 Tr. IS 4618 appendix.	* Special ca	tegories of cited documents :				
The document which may throw double on priority claim(s) or which is cited to establish the publication date of another chation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed Date of the actual completion of the international search Date of the actual completion of the international search Date of mailing address of the ISA European Patant Office, P.B. 5618 Patentiaen 2 Name and mailing address of the ISA European Patant Office, P.B. 5618 Patentiaen 2 Na 2280 MV Rijawijs. Tot (481-77) 340-2040 T. D. 5618 patentiaen 2	"A" docume	ont dofining the general state of the last which is not larged to be of particular relevance	or priority date and not in conflict with clied to understand the principle or the invention	the application but sory underlying the		
Tut document which may throw double on priority claims) or which is cited to establish the publication date of another chatton or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed Date of the actual completion of the international search 22 January 1999 Name and mailing address of the ISA European Patant Office, P.B. 5618 Patentiaen 2 NL - 2280 HV Rijawijs. Each Call And Call of the ISA (248-77) 248-0-246 TV IS 6518 patentiaen 2 NL - 2280 HV Rijawijs.	l imung a	MANG CONTRACTOR CONTRA	cannot be considered novel or cannot	be considered to		
"O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but lefter than the priority date claimed Date of the actual completion of the international search Date of meiling of the international search report 22 January 1999 Name and mailing address of the ISA European Patent Office, P.B. 5618 Patentiaen 2 NL - 2280 HV Rijswijk. Tot (481-77) 340-2040 TV RIJSWIjk.	NAME OF THE PARTY	in Great to decident the ollowestion date of smother	involve an inventive step when the do "Y" document of particular relevance; the o	cument le taken sione tomed invention		
"P" document published prior to the international filing date but in the art. "8" document member of the same patent family Date of the actual completion of the international search Date of meiling of the international search report 22 January 1999 Name and mailing address of the ISA European Patent Office, P.B. 5618 Patentiaen 2 NL - 2280 HV Rijawijk. Tel (481-77) 340-2946 To 19 5818 posterior and search report)	*O* docum	ent referring to an oral disclosure, use, exhibition or	document is combined with one or ma	re other such docu-		
Date of the actual completion of the International search 22 January 1999 Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentiaen 2 NL - 2280 HV Rijswijk. Tot (481-77) 340-2040 TV IS 6818 and	"P" docume	ent published prior to the international filling data but	in the art.	•		
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentiaen 2 NL - 2280 HV Rijswijk Tol (481-70) 340-2040 TV St 584 and del			·			
European Patant Office, P.B. 5618 Patentiaan 2 NL - 2280 HV Rijswijk.	2	2 January 1999	09/02/1999	09/02/1999		
NL - 2230 HV Rijswijk	Name and r		Authorized officer			
		NL - 2280 HV Rilswift	Moyle, J			

INTERNATIONAL SEARCH REPORT

P sational Application No PCT/US 98/22671

		PCT/US 98/226/1
C.(Continue	ITION) DOCUMENTS CONSIDERED TO BE RELEVANT	*
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 343 380 A (CHAMPLIN KEITH S) 30 August 1994 cited in the application see the whole document	1-26
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 089 (P-444), 8 April 1986 å JP 60 225078 A (NISSAN JIDOSHA KK), 9 November 1985 see abstract	1-24
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 253 (E-1367), 19 May 1993 & JP 04 372536 A (OMRON CORP), 25 December 1992 see abstract	23
Y	PATENT ABSTRACTS OF JAPAN vol. 016, no. 398 (P-1408), 24 August 1992 & JP 04 131779 A (FUJI ELECTRIC CO LTD), 6 May 1992 see abstract	23
Y	PATENT ABSTRACTS OF JAPAN vol. 016, no. 105 (P-1325), 16 March 1992 å JP 03 282276 A (YUASA BATTERY CO LTD), 12 December 1991 see abstract	17,18
A .	PATENT ABSTRACTS OF JAPAN vol. 016, no. 096 (P-1322), 10 March 1992 & JP 03 274479 A (YUASA BATTERY CO LTD), 5 December 1991 see abstract	9
•		

5----------

1

Form PCT/ISA/210 (continuation of second sheet) (July 199)

INTERNATIONAL SEARCH REPORT

information on patent family members

PCT/US 98/22671

Patent document cited in search report		t	Publication date	Patent family member(s)		Publication date
US 4423379		Α	A 27-12-1983			
US	5457377	A	10-10-1995	FI DE GB	924425 A 4333520 A 2271229 A,B	02-04-1994 07-04-1994 06-04-1994
US	3984762	A	05-10-1976	NONE		
GB	2088159	A	03-06-1982	NONE		
US	5343380	A	30-08-1994	AU WO	5606594 A 9411938 A	08-06-1994 26-05-1994